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ABSTRACT

Thirty-six children between four and seven years of age were asked a series of questions to determine their degree of insight (meta-cognitive awareness) regarding the way four common variables influence the ease with which a person can perform the three cognitive tasks of remembering, communicating, and attending. The four variables were the length of the task, noise interference, age of the person performing the task, and time allotted for the task. Analysis of the results indicated that the pattern of understanding was the same with regard to the different cognitive realms, that more children understood the effects of length and noise interference than those of age and time, and that children's levels of understanding increased with age. (Descriptions and examples of pictorial stimuli used in the study, and tables of results, are included.) (GW)

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Technical Report No. 452

THE DEVELOPMENT OF META-COGNITIVE AWARENESS IN MEMORY, COMMUNICATION, AND ATTENTION

by

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Report from the Project on
Studies of Instructional Programming for the Individual Student

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Table of Contents

	Page
List of Tables	vii
List of Figures	vii
Abstract	ix
Introduction	1
Method	3
Pilot Study	3
Subjects	4
Design	4
Stimuli	4
Procedure	6
Results and Discussion	8
Main Findings	8
Other Findings	10
Final Thoughts	11
References	15
Footnotes	17

List of Tables

Table		Page
1	Summary Descriptions of the Pictorial Stimuli Associated with the Three Cognitive Tasks	19
2	Means and Standard Deviations of Scores for the Three Cognitive Tasks and Four Variables for the Four Year Olds	21
3	Means and Standard Deviations of Scores for the Three Cognitive Tasks and Four Variables for the Six Year Olds	23

List of Figures

Figure		Page
1	Example of pictures used to probe the child's understanding of the impact of list length on memory	
	a) 3 items to remember	25
	b) 10 items to remember	27
2	Mean scores on all variables both corrected and uncorrected	29

The Development of Meta-Cognitive Awareness in Memory, Communication and Attention

Introduction

Recently, investigators have turned their attention to meta-cognitive aspects of intellectual development. Meta-cognition, or "knowing about knowing" (Brown, 1978) refers to the insights people have about cognitive processes. A number of psychologists have argued that this insight may be central for understanding the growth of intelligent behavior--and may even be as important as the study of the cognitive performances to which the insights are tied (e.g., Brown, 1978; Flavell & Wellman, 1977; Wertsch, 1978).

There are, by now, a large number of well-documented developmental changes in one meta-cognitive domain, memory. Investigators have shown that during the elementary school years children become increasingly accurate in predicting their memory spans (e.g., Flavell, Friedrichs, & Hoyt, 1970; Yussen & Levy, 1975), in identifying the utility of various mnemonic strategies such as semantic organization (e.g., Moynahan, 1973), rehearsal (Brown, 1978), and ordered retrieval (e.g., Yussen & Levy, 1977), and in gauging the current state of their memories (e.g., Wellman, 1977).

Very little is known about meta-cognitive development in skills other than remembering, however. For example, there is little systematic research in areas such as language, communication, problem solving, or perception and attention. Though different cognitive processes are no doubt important in each of these task-domains, there may be a developing

core of meta-cognitive insights which is central to these and other cognitive skills. Some theorists are now pointing to common dimensions of change across different developmental realms (e.g., Flavell, 1977; Miller, 1977; Pick, Frankel, & Hess, 1975). If meta-cognitive awareness is truly central in the unfolding picture of cognition, it should be possible to pinpoint commonalities in its development across different domains. This study is an attempt to do just this. Children's understanding of the impact of four critical variables on performance was assessed for memory, communication, and attention. It was expected that understanding would be parallel for each cognitive task.

The specific impetus for the present research was a study recently reported by Wellman (1977). He presented children between three and five years of age with pairs of pictures depicting hypothetical children in situations favorable or unfavorable to memory. Subjects were asked to select the hypothetical child in each pair who had the more difficult memory task. The pairs were designed to tap the children's awareness of the following facts about demands, strategies, and cues in memory tasks: (1) that a longer list of items is more difficult to remember than a shorter one, (2) that noise interferes with performance, (3) that a baby is less skilled than an adult, (4) that a friend may provide help, (5) that longer study time is beneficial, (6) that drawing an object to be remembered aids its retrieval, and (7) that meaningful, associated verbal cues enhance recall. It was demonstrated that, with increasing age, children answered more of the questions consistently and correctly. There was also a clear order of emergence in the children's understanding of the various memory questions. For the purpose of this discussion, the most important finding

was this: a relatively large number of children were aware of the impact of both noise and list length upon memory, though few of them divined the importance of any of the other variables.

This study sought to assess the general nature of early meta-cognitive awareness by probing children's understanding of the relevance of some of Wellman's (1977) meta-memorial variables on three different cognitive tasks: memory, communication, and attention. Only those variables thought to be salient for all three tasks and not specifically related to memory problems were included. Consistent with Wellman's findings, two of the variables, list length and noise interference, were expected to be understood by most children. By contrast, two other variables, study time and age of the task performer, were expected to be understood by fewer children. At the same time, it was predicted that preschool children would be less likely than first graders to understand each of the variables, and that this would be true regardless of the task under consideration.

Method

Pilot Study

Fifteen children (seven female) ranging in age from 3-7 to 4-10 were tested with the general procedure described below, though two extra practice test pairs were shown to several subjects. Results of the pilot showed no noticeable differences among the cognitive tasks in response to each pair, with mean scores of 1.03, 1.08, and 1.08 on the memory, attention, and communication tasks, respectively, out of a maximum score of two. There was a clear ordering of mean scores on all questions concerned with the four variables, however. Most subjects answered questions about interference ($\bar{X}$ = 1.53) and length ($\bar{X}$ = 1.22) correctly; some were

aware of the importance of age ($\bar{X}$ = .91); and only a few were aware of the importance of time ($\bar{X}$ = .60). The experiment proper was carried out to test the generality of these findings with a new sample of four year olds. To determine whether children slightly older would be much more aware of the importance of the meta-cognitive variables under study, a sample of first-graders was also tested.

Subjects

There were 36 children,[1] half chosen from several preschool classes (mean age, 4 - 6) and half from first grade classes (mean age, 6 - 7). All children were middle class and drawn from private schools in Madison, Wisconsin. There were an equal number of boys and girls at each age.

Design

All subjects at each level received test pairs for all three tasks (attention, communication, and memory) and four variables pertaining to each one (length, interference, time, and age). There were two test pairs for each task X variable concept--one striking a maximum contrast, the other a minimum contrast. Each task and the eight accompanying questions (four variables X two test pairs) were presented in a separate session, with the order of tasks and questions within a task randomized across subjects.

Stimuli

The children's awareness of the impact of each variable for a particular task was tested with a pair of pictures which were line drawings colored in with pencil on 9 x 25 cm cards. Each member of the pair depicted a girl engaged in one of the three cognitive tasks. From an adult perspective, one girl had the easier version of the problem, the

other the harder. An example of a stimulus picture is illustrated in Figure 1. Girl 1a is depicted trying to remember three pictures, while girl 1b is shown with ten. This stimulus served as the basis for the maximum contrast in the meta-memory question about length. In all, there were 24 such pairs. For each cognitive task, a similar pictorial format was used. However, the particular girls and study items depicted

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Insert Figure 1 about here

(i.e., miniature pictures in the memory task, animals to be watched in the attention task, or activities mentioned in the communication task) were changed to reduce boredom and to emphasize the differences between the three cognitive tasks. A summary of the key elements of the pictorial pairs across tasks and variables is presented in Table 1.

Insert Table 1 about here

There were three pairs of pictorial stimuli used for practice: a girl was shown (a) jumping over a high or low brick wall, (b) trying to throw a ball through a large or small window, and (c) wearing a striped or polka-dotted hair ribbon while pulling a wagon. Pilot testing revealed that many children were biased towards responding that "big things are harder," i.e., that any child depicted in a task using more numerous or larger items than another would be performing the more difficult feat. Thus, the first two practice pairs were chosen to tap a correct use of this generalization (pair A) and an incorrect use (pair B). Pair C tested the subject's tendency to report a difference even when no difference

relevant to the task was present.

Procedure

Children were tested by the second author in a free room at their school. There were approximately three days between each of the three 20-to-25 minute sessions. During the first session, the child was shown the three practice pairs one at a time and asked, "Which girl has the harder job (of doing the task)?" Children were told that the girls depicted in each pair were twins, i.e., that they were sisters with the same birthday who "look alike" and "even think alike." This was done to encourage children to focus only on the feature of interest in each pair. Subjects were asked to point to one member of each pair and to give a reason for their choice or for their indecision if no response was offered. After the pictures were shown, subjects were asked the following questions to test their knowledge of temporal concepts: (1) "Which do you think is longer, a second or a minute?" and (2) "Would you rather play outside for a few seconds or for a few minutes?"[2]

Immediately after practice items were given, subjects were introduced to the first task about which they would be questioned with a practice exercise. For the memory task, subjects were shown colored drawings of an apple, a pencil, and a fish and asked to recall the names of these items after their removal.

For the attention task, practice was carried out with a simulated window through which subjects were asked to watch three animals. For this, subjects were seated before a 41 x 41 x 36 cm deep box with a square Plexiglas window on the front. There were three cardboard shadow-boxes attached to the back of the Plexiglas window. Each one revealed a colored

photograph of a common animal--a fawn, a snake, or an ape. The window was "dirtied" by painting areas of the Plexiglas gray to expose the three "clear spots" through which "the animals which have escaped from the zoo" could be seen. Subjects were encouraged to watch "everything the animals are doing," which required repeated shifts of attention (and movement) from one "clean spot" to the next.

Finally, the communication task was explained to the children by showing them a doll, introduced as an imaginary friend, to whom they would tell a story. The doll was hidden and children were shown three colored drawings representing activities they were asked to pretend to have done that day. The pictures were of a hand holding an ice cream cone, a hand drawing a picture of a boat, and a mouth singing. The doll was reintroduced and the subjects were asked to tell the friend what they had done that day, i.e., to describe the pictures.

During each session, subjects were shown each of the eight pairs for a particular task while the experimenter described the critical difference between the pictures. Subjects were then asked, "Which girl has the harder job to make sure her friend understands everything she did that day (communication task), to remember the pictures (memory task), or to look at the animals and watch everything they are doing (attention task)?" Usually, subjects pointed to a picture before the experimenter finished this sentence. If they hesitated, the experimenter added a question which had been asked during practice and on the first test trial, "or do you think they will both find the job about the same?" Children were then asked to give a reason for their response. Left-right placement of pictures within a test pair was randomized across pairs, with the restriction that correct alternatives appeared equally often on each side.

Results and Discussion

The basic datum of interest is the child's reaction to the two test questions dealing with each task X variable concept, e.g., memory questions on length. A score ranging from 0 to 2 was assigned in the following way: incorrect responses to both test questions received a score of 0; a correct response to one question received a 1; and correct responses to both questions received a 2. Means and standard deviations for each task and variable appear in Table 2 (four year olds) and Table 3 (six year olds).

Insert Tables 2 and 3 about here

In addition, there is supplementary information on (a) the children's responses to the practice items, (b) responses to the preliminary questions about time ("minutes and seconds"), and (c) the verbal explanations accompanying responses to test questions.

Main Findings

Two analyses of variance--one for each age group--were conducted to evaluate the effect of the repeated measures of Task (3) and Variables (4) on children's responses to the test pairs. Preliminary inspection of the data revealed no differences due to sex or the degree of contrast present in the test pairs. Therefore, these factors were not considered in the formal analysis. The significance level was set at $\alpha = .05$ for each effect. The separate analyses were motivated by the apparent ceiling effect in the responses of the older children (see the means in Table 3). For each analysis, a common pattern of results was found. There was a significant main effect of variables ($F = 8.09$ for the four year olds, and 7.01 for

the six year olds; df = 3,187, $p < .001$) but none for task or the interaction of task X variables. Follow-up comparisons were performed on the significant effect of variables using Scheffe's (1953) procedure, with $\alpha = .1$. A common pattern also appeared for the two age groups. Children achieved higher scores on the questions dealing with length and interference combined than on questions dealing with age and time.[3] No other differences among the means were found to be significant.

Due to differences in language skills and verbal responsivity of children, there was no formal analysis of the verbal explanations given for test choices. However, an informal correction procedure was employed in which children's choices were discounted in the absence of a correct, relevant explanation. A correct, relevant explanation referred to the attribute in question specifically (e.g., "she has 10, but the other girl only has 3 to do") or the implied general cognizance of it (e.g., "she has more than the other girl"). Explanations from children's protocols were rated independently by two judges. This correction lowered the accuracy of all response types, but, in general, did not change the pattern of findings. In Figure 2, the data are presented in graphic form, showing this relation between "corrected" and "uncorrected" scores.

Insert Figure 2 about here

The findings are consistent with the authors' preliminary expectations. For a portion of the results obtained by Wellman (1977), children's understanding of what influences memory is paralleled by their understanding of what influences other cognitive "acts"--here, oral communication and

attention. There is much greater understanding of the impact of task length and interference on cognitive performance than understanding of the importance of a cognizer's age or the amount of time to act. Although overall understanding increases with age, even the six year olds displayed this differential understanding.

Other Findings

As might be expected, the practice items were handled more easily by the six year olds than by the preschoolers. Only one subject, a four year old, answered the first pair incorrectly, while four of the four year olds and one six year old answered the second pair incorrectly. This is the "size" or "magnitude" bias spoken of earlier. Perhaps these four year olds had a bias toward responding that large things are always more difficult. However, this did not appear to be the case, as the average score of subjects answering this practice item incorrectly ($\bar{X} = 1.23$) was no lower than that of subjects answering correctly ($\bar{X} = 1.11$).

Six year olds also appeared to have a better grasp of temporal concepts than the four year olds. The two practice questions about time were answered correctly by 61 percent of the six year olds and only 17 percent of the four year olds. Despite the younger subjects' difficulty with temporal concepts, there appeared to be no relation between answers to the practice questions about time and answers to the test pairs concerned with time. Eleven four year olds who answered at least one time question correctly received an average score of 0.76 on the time test pairs, while the seven subjects who answered both questions incorrectly received an average score of 0.90 on the time pairs.

Although the sample size does not allow for a robust analysis of individual differences, it is possible to obtain some impression of the intraindividual similarity of children's choices across the different cognitive tasks. Pearson product-moment correlations were computed on subjects' scores on the same meta-variable across the three tasks. For the preschoolers, there was great consistency. All correlations were positive and in seven of twelve possible cases, statistically significant ($r = +.51$ to $+.76$; mean = $+.65$). For the six year olds there was only moderate consistency, perhaps due to the more limited range of scores. Omitting the low correlations for the variable "noise," where there was an obvious ceiling effect, eight of the remaining nine correlations were positive and four were significant ($r = +.53$ to $+.81$; mean = $+.64$). Thus, a reasonable inference is that children offer similar responses to questions about the same meta-variable for different cognitive tasks.

Final Thoughts

The data reported are primarily descriptive in nature and are likely to generate two related, and at the moment, unanswered questions. What accounts for these descriptive patterns of change? How can we explain the finding that children have a good grasp of one cognitive "fact" before (developmentally) they grasp another? There are at least two explanations which seem plausible.

First, children are likely to comprehend the importance of factors which frequently enter into and influence everyday cognitive tasks similar to the ones employed here. In this view, the length of a task and the presence of interfering events are parameters that the child frequently experiences and ones that dramatically shape his or her performance.

Wellman (1977) emphasizes this point.

We prefer a second explanation, which turns on the nature of the variables that are considered. Length and interference are both concrete attributes of situations; they carry little surplus or extraneous meaning, and can be discerned in an immediate, static fashion. Time and age are more abstract qualities of situations. Although one can represent them fairly concretely as we did in the stimulus pictures, it is difficult to separate the many features of these variables from the single ones that bear on the task at hand. In this respect, some of the children's incorrect explanations and spontaneous reactions to the pictures are informative. For example, when questioned about time, one child remarked that she might get tired of talking if given more time; another, that he might "forget" with too much time to study. For questions about age, one child remarked that grownups are too tall to see; another, that grownups don't like doing certain things. In short, these children had a number of ideas which were plausible for these two abstract variables, but the associations were idiosyncratic. It was as if the children were captured by irrevelant, surface, features of these variables and failed to comprehend the central, underlying advantage associated with being older or having more time.

This study was a first attempt to document the common insights which children apply across different cognitive realms. As such, it only scratches the surface of a potentially exciting and fruitful line of inquiry. A number of important questions still cry out for answers. A partial list includes questions such as these: Do children have the same insights as reported here for other cognitive activities? What other task variables also apply quite generally to these cognitive realms?

What of the understanding of older children; what are the general, cognitive insights that develop for them? It is clear that the current study marks just a beginning. Much is yet to be learned.

References

Brown, A. L. Knowing when, where, and how to remember: a problem of meta-cognition. In R. Glaser (Ed.), Advances in Instructional Psychology. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1978.

Flavell, J. H., Friedrichs, A. G., & Hoyt, J. D. Developmental changes in memorization processes. Cognitive Psychology, 1970, 1, 324-340.

Flavell, J. H. Meta-cognitive development. Paper presented at the NATO Advanced Study Institute on Structural/Process Theories of Complex Human Behavior. Banff, Alberta, Canada, June 1977.

Flavell, J. H., & Wellman, H. M. Meta-memory. In R. V. Kail, Jr., & J. W. Hagen (Eds.), Perspectives on the Development of Memory and Cognition. Hillsdale, N. J.: Lawrence Erlbaum Associates, 1977.

Miller, P. Symposium on attention and cognition. Discussant's remarks. Meeting of the Society for Research in Child Development, New Orleans, March 1977.

Moynahan, E. D. The development of knowledge concerning the effect of categorization upon free recall. Child Development, 1973, 44, 238-246.

Pick, A. D., Frankel, D. G., & Hess, V. L. Children's attention: The development of selectivity. In E. M. Hetherington (Ed.), Review of Child Development Research (Vol. 5). Chicago: University of Chicago Press, 1975.

Scheffe, H. A. A method for judging all possible contrasts in the analysis of variance. Biometrika, 1953, 40, 87-104.

Wellman, H. M. Preschooler's understanding of memory-relevant variables. Child Development, 1977, 48, 1720-1723.

Wertsch, J. V. Adult-child interaction and the roots of metacognition. The Quarterly Newsletter of the Institute for Comparative Human Development, The Rockefeller University, 1978, 2, (number 1), 15-18.

Yussen, S. R. & Levy, V. M., Jr. Developmental changes in predicting one's own span of short-term memory. Journal of Experimental Child Psychology, 1975, 19, 502-508.

Yussen, S. R. & Levy, V. M., Jr. Developmental changes in conscious knowledge about different retrieval problems. Developmental Psychology, 1977, 13, 114-120.

Footnotes

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[1]In the original sample of the main study, there were 44 children. One four year old was rejected for failing to complete his first task and one six year old was rejected for a long illness which interrupted testing. Further, to create equal numbers of girls and boys at each grade level, three female preschoolers and three male first graders were randomly omitted from the sample.

[2]At the outset of the study, the authors wondered whether young children understand that a "minute" is longer than a "second." These terms were used to frame the test questions about time.

[3]Since there was a clear ceiling effect for the group of six year olds in the attention task for the variable of noise (mean = 2.0, variation = 0), an alternate ANOVA was attempted. Eliminating the variable of noise, this left a 3 (Task) X 3 (Variable) design. The same significant effect

of Variables was found, with post hoc tests similarly revealing higher scores for questions about length than for questions about age or time.

[4]To denote different intervals of time, circular cardboard "clocks" were pasted on the stimulus pictures, with red pie-shaped wedges varying in size. Three different angles were used for the wedges, 20°, 120°, and 225°, signifying time periods of a few seconds, a few minutes, or 10 minutes, respectively. The clocks also varied somewhat in size, with the smallest clock representing a few seconds and the largest clock representing 10 minutes.

Table 1

SUMMARY DESCRIPTIONS OF THE PICTORIAL STIMULI ASSOCIATED WITH THE THREE COGNITIVE TASKS

MEMORY	COMMUNICATION	ATTENTION
A girl is seated at a table in front of several drawings of objects which she has to remember.	A girl is shown telling another girl about her activities that day. A conversation "balloon" encloses depictions of the former girl carrying out several activities.	A girl is shown looking out a window at an array of several animals, whose activities she is to monitor simultaneously.

	VARIABLE			
PAIR	LENGTH	NOISE	AGE	TIME[a]
1. Dramatic Difference	10 items in the depicted task	depictions of a radio playing, a telephone ringing and a car accident	a tall woman performs the task	a clock indicates 10 minutes for the task
	vs.	vs.	vs.	vs.
	3 items in the depicted task	quiet room	a very young girl performs the task	a clock indicates a few seconds for the task
2. Minimal Difference	4 items in the depicted task	one of the noise depictions shown (randomly chosen)	a girl "one year older" performs the task	a clock indicates a few minutes for the task
	vs.	vs.	vs.	vs.
	3 items in the depicted task	quiet room	a smaller girl "your age" performs the task	a clock indicates a few seconds for the task

[a]To denote different intervals of time, circular cardboard "clocks" were pasted on the stimulus pictures, with red pie-shaped wedges varying in size. Three different angles were used for the wedges, 20°, 120°, and 225°, signifying time periods of a few seconds, a few minutes, or 10 minutes, respectively. The clocks also varied somewhat in size, with the smallest clock representing a few seconds and the largest clock representing 10 minutes.

Table 2

MEANS AND STANDARD DEVIATIONS OF SCORES FOR THE THREE COGNITIVE TASKS AND FOUR VARIABLES FOR THE FOUR YEAR OLDS

Variables		Cognitive Task			
		Memory	Attention	Communication	Total
Noise	$\bar{X}$	1.83	1.67	1.56	1.69
	S.D.	.51	.59	.78	.46
Length	$\bar{X}$	1.50	1.56	1.50	1.52
	S.D.	.79	.78	.71	.69
Age	$\bar{X}$	1.06	1.17	1.28	1.17
	S.D.	.94	.92	.83	.65
Time	$\bar{X}$	.89	.72	.83	.82
	S.D.	.76	.90	.86	.72
Total	$\bar{X}$	1.32	1.28	1.29	1.30
	S.D.	.30	.47	.45	-

Table 3

MEANS AND STANDARD DEVIATIONS OF SCORES FOR THE THREE COGNITIVE TASKS AND FOUR VARIABLES FOR THE SIX YEAR OLDS

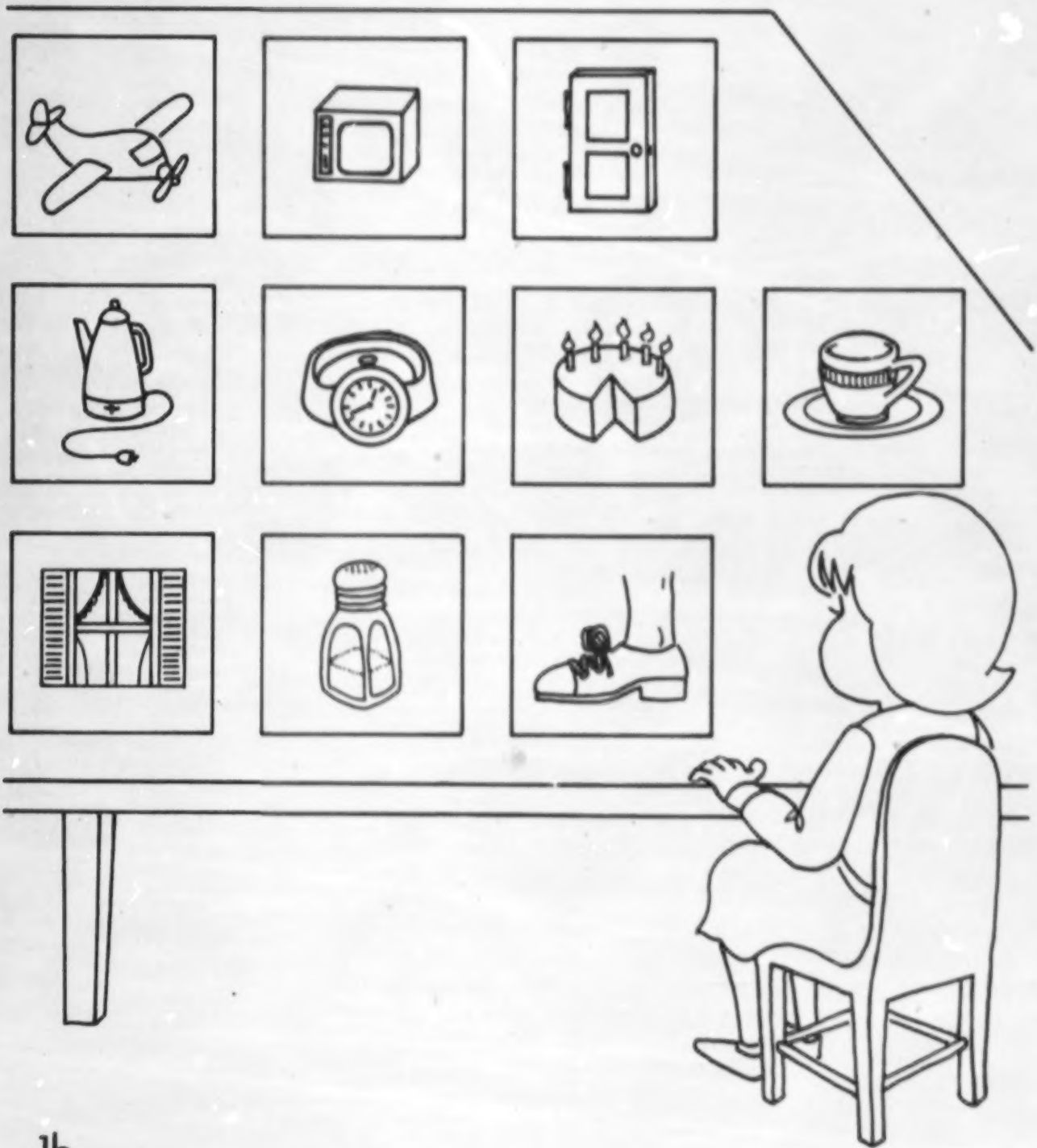
Variables		Cognitive Task			
		Memory	Attention	Communication	Total
Noise	$\bar{X}$	1.90	2.00	1.94	1.94
	S.D.	.47	0	.24	.17
Length	$\bar{X}$	1.83	1.94	1.89	1.90
	S.D.	.38	.24	.32	.26
Age	$\bar{X}$	1.39	1.79	1.56	1.57
	S.D.	.85	.55	.78	.55
Time	$\bar{X}$	1.61	1.33	1.72	1.56
	S.D.	.78	.91	.58	.56
Total	$\bar{X}$	1.68	1.76	1.78	1.74
	S.D.	.34	.25	.30	-

Figure Captions

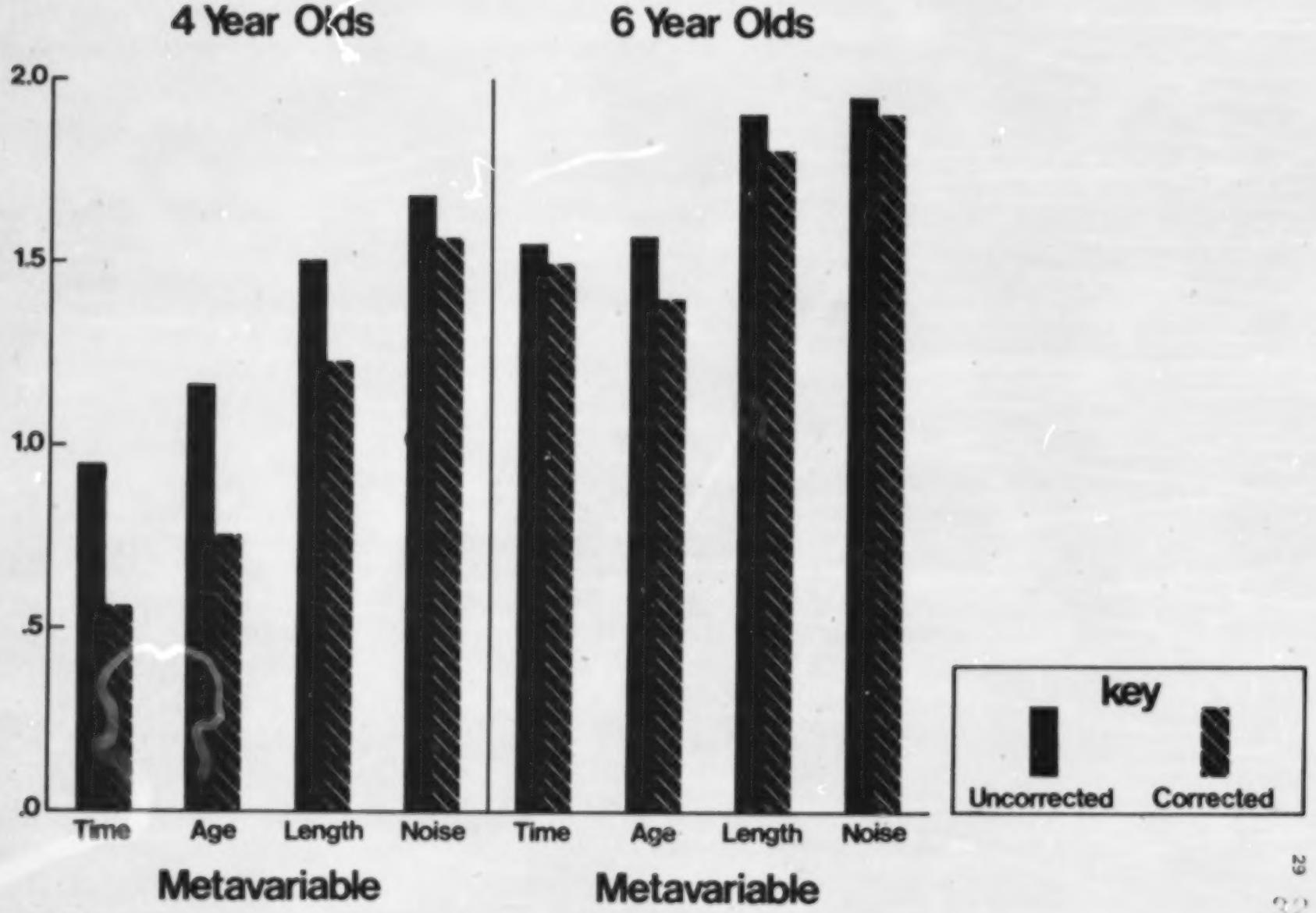
Figure 1. Example of pictures used to probe the child's understanding of the impact of list length on memory. a) 3 items to remember, b) 10 items to remember.

Figure 2. Mean scores on all variables both corrected and uncorrected.

1a



1b


4 Year Olds
6 Year Olds
2.0
1.5
1.0
.5
.0
Time
Age
Length
Noise
Time
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Noise
Metavariable
Metavariable
key
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